
Space Weather Technical Forecast

Issued on Wednesday, 20 March 2024 at 12:47 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-flares likely (R1-R2 Radio blackouts), slight chance of X-flares (R3 blackouts). Chance of G1 from CME arrivals mainly late Day 1 (20 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate, with the largest flare M7.4 peaking at 20/0736 UTC from AR3615 in the southeast. There are currently eight sunspot regions on the visible disc. The two regions of most interest are AR3614 in the northeast (likely ex-3590 from the previous rotation which gave three X-flares, including X6.3 the largest of the solar cycle so far) and AR3615 in the southeast. AR3614 has a large main spot with a clear delta configuration, whereas AR3615 has a large number of smaller spots, but is showing a couple of delta regions. AR3616 in the west showed signs of decay. AR3607 has seen some growth of intermediate spots recently. A new spot region, as yet unnumbered, is appearing around the southeastern limb and its analysis will be re-assessed as it becomes more clearly visible. The remaining regions currently appear stable or showing slight decay. No Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds as observed by DSCOVR at L1 were at ambient to slightly elevated levels through the period. Wind speeds were between 340-400 km/s. Density was average or below. Interplanetary Magnetic Field, Bt, was weak throughout, at 6nT or below. The north-south component, Bz, varied weakly between +/-5nT. Phi angle was variable. Geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is close to background levels after the S1 enhancement on 15-16 Mar. High energy electron flux (greater than 2MeV) observed at GOES16 was at background levels. The observed 24-hour fluence was below the Active threshold, with a value at 20/0001 UTC of 1.03e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely with a slight chance of becoming High with any isolated X-flares, mostly due to AR3614 and AR3615, but regions in the west still bear keeping an eye on.

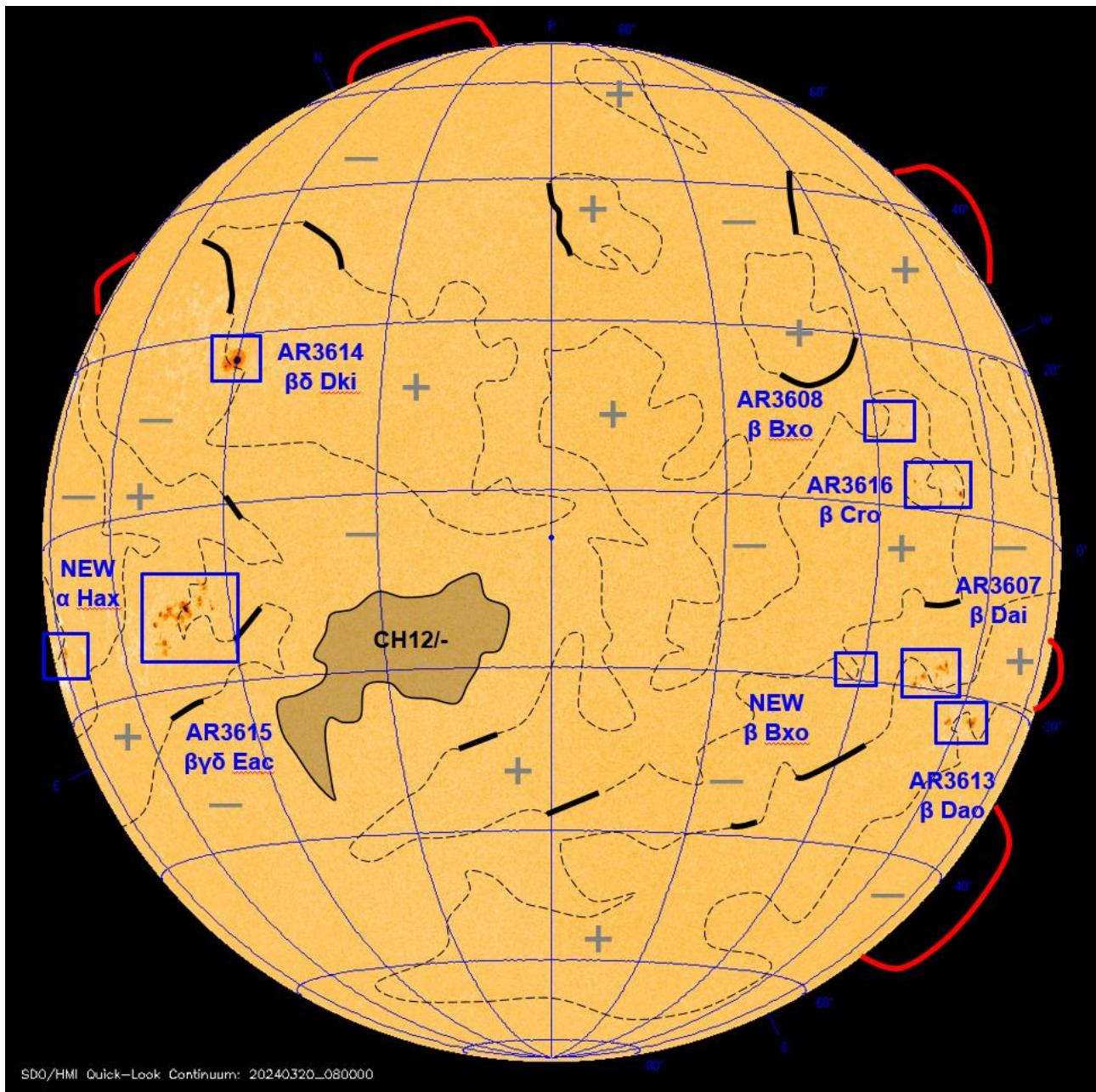
Solar Wind / Geomagnetic Activity: A complex filament eruption on 17 Mar saw two possible Earth-directed CMEs. The arrivals of these are expected during Day 1 (20 Mar) or into early Day 2 (21 Mar), perhaps arriving as two separate shocks but may also arrive together. The more likely impact is from the slower of the two CMEs, but perhaps also a glancing blow from the slightly faster and further south CME. Ongoing effects are possible during Day 2 (21 Mar), before then easing. Aside from the CMEs, no other sources of notable enhancement to solar winds are forecast.

Geomagnetic activity is expected to be Quiet to Unsettled (Kp1-3), with a chance of Active or G1/Minor Storm and a slight chance of G2/Moderate Storm conditions (Kp4-6) Day 1 into Day 2 from the CME. Effects are then likely to decline through Day 2, becoming largely Quiet by Day 3 (22 Mar) in the absence of further CMEs.

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Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux at GOES18 is expected to remain around background levels, with a slight chance of further enhancements. This risk increases slightly through the period as AR3614 and AR3615 rotate towards centre disc. High energy electron flux (greater than 2MeV) is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME was observed from a filament eruption from the southeast disc, occurring near AR3613 at around 17/0230 UTC. This is a complex eruption, splitting into two separate CMEs. The first one went to the southeast, and is faster, narrower but brighter on imagery, possibly giving a glancing impact during Day 1 (20 Mar). The second to the southwest is fainter, slower and wider, and consequently more likely to be observed arriving at Earth and is also expected later on Day 1, with ongoing effects possible into Day 2 (21 Mar), before then easing.

Aside from the CMEs, no other sources of notable enhancement to solar winds are forecast, with no coronal hole influences expected during the forecast period.

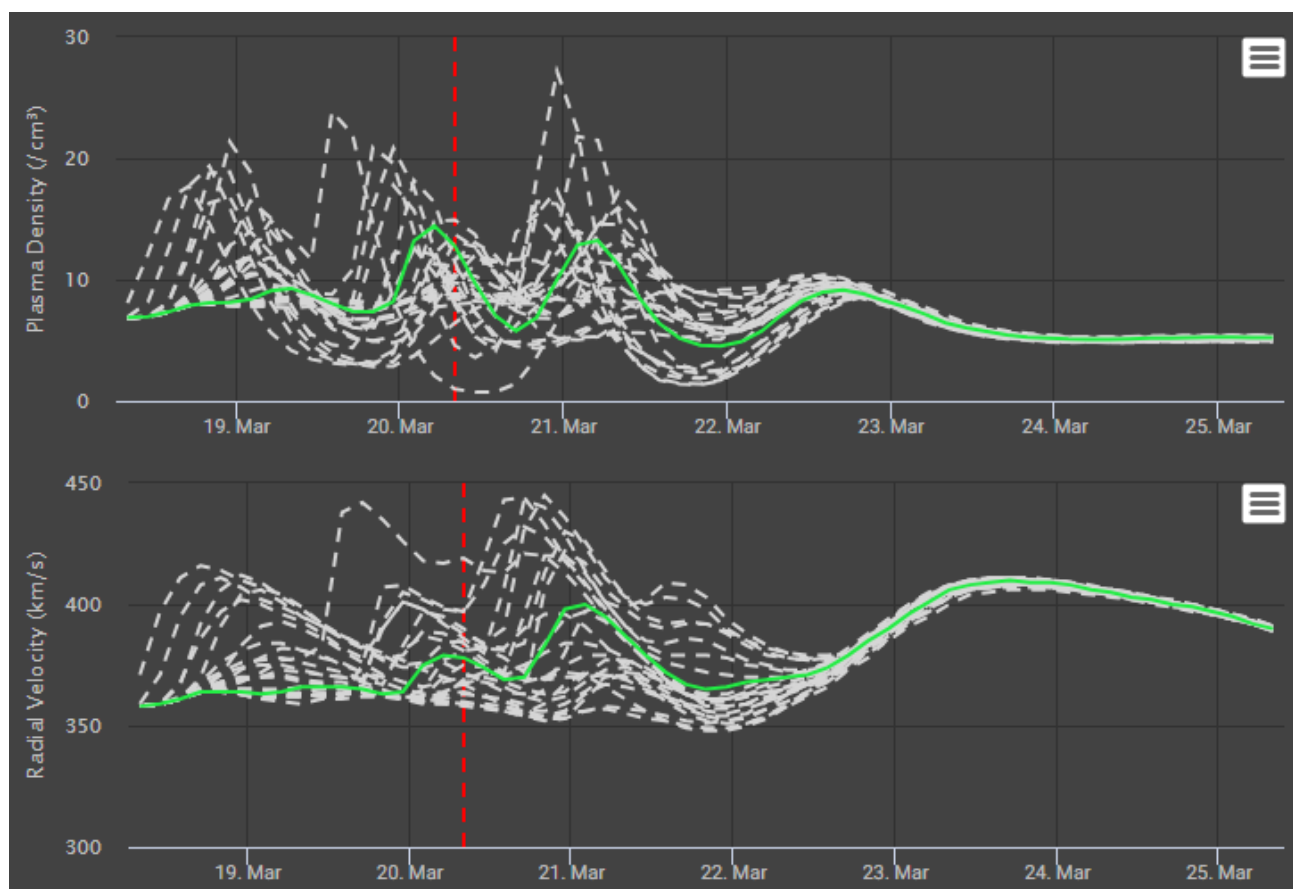
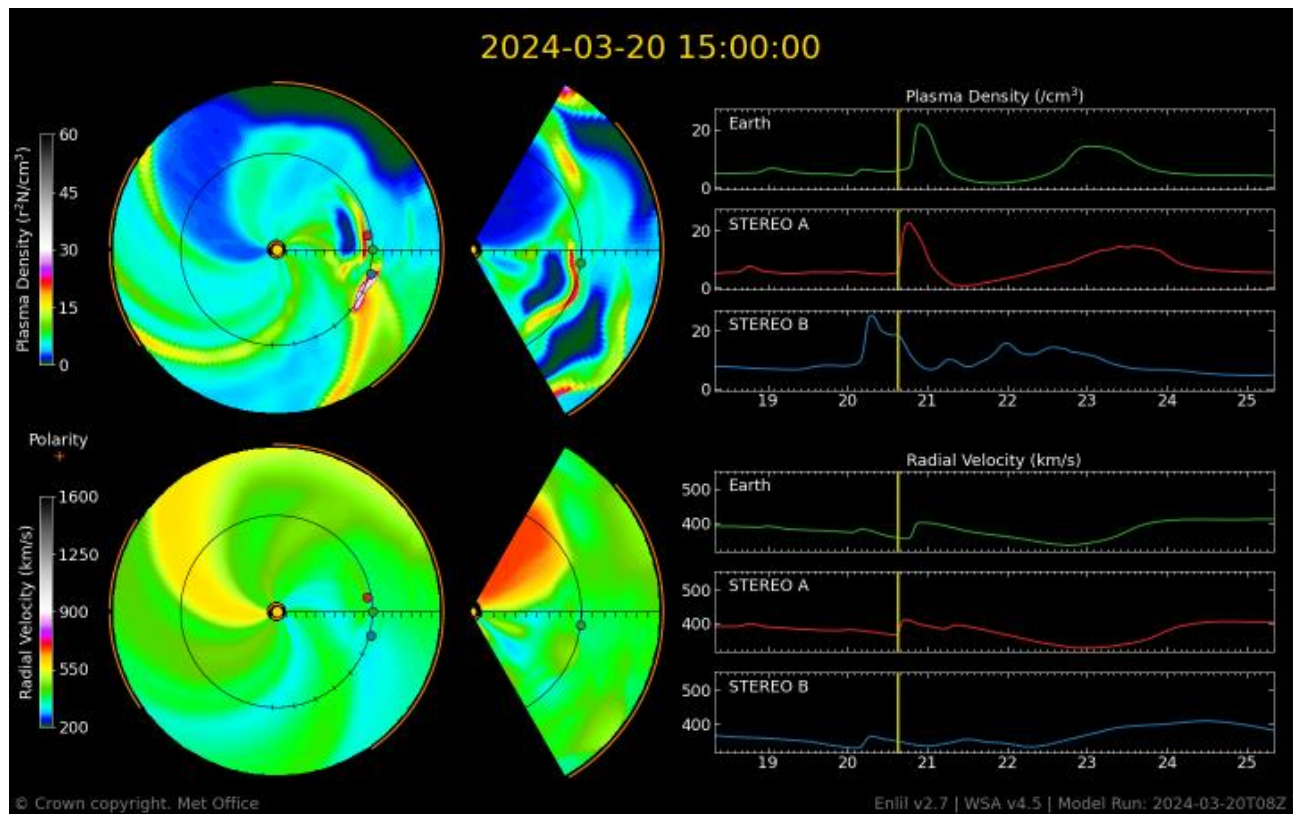
Geomagnetic activity is expected to be Quiet to Unsettled, with a chance of Active or G1/Minor Storm and a slight chance of G2/Moderate Storm conditions Day 1 and into Day 2, in association with the filament eruption CME from the 17 March. Effects are then likely to decline later through Day 2, becoming largely Quiet for Days 3-4 (22-23 Mar) in the absence of further CMEs.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	50	40	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/1035	Partial	Filament	SW, near AR3613	505 km/s	20/2000 UTC	Moderate confidence. Perhaps preceded by glancing blow.

Figure 2: MOSWOC Enlil and ensemble, showing a likely CME arrival later on 20 March.



Radio Blackouts - X-Ray Flares:

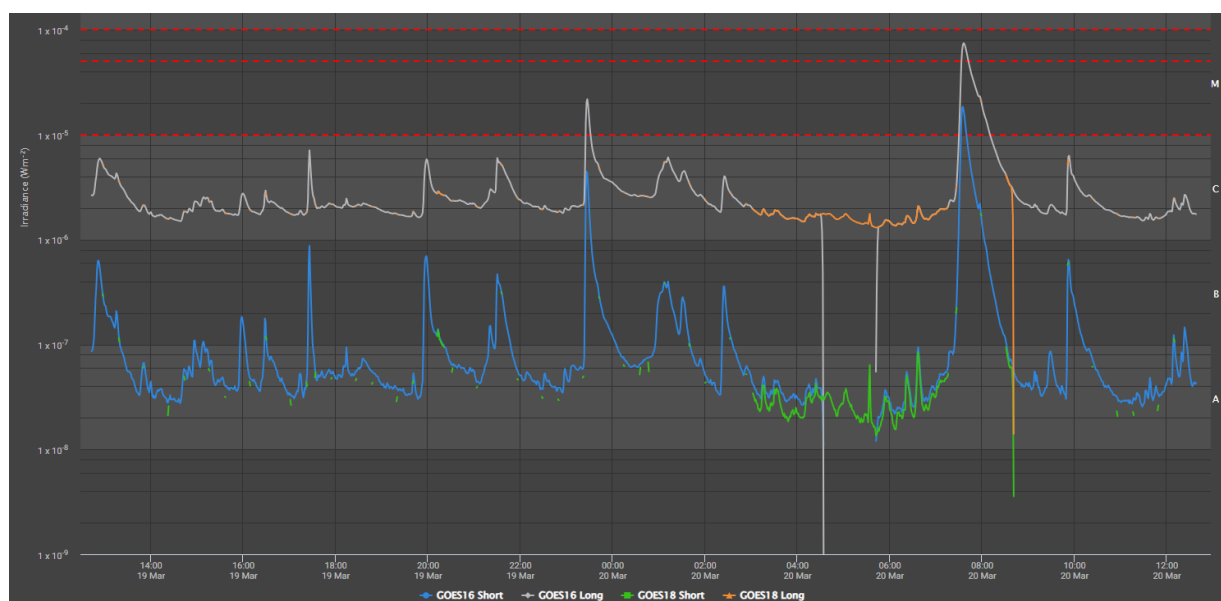
Activity has been Moderate, with the largest flare M7.4 peaking at 20/0736 UTC from AR3615 in the southeast.

There are currently eight sunspot regions on the visible disc, with AR3611 fading and a new region developing east of AR3607. The two regions of most interest are AR3614 in the northeast (likely ex-3590 from the previous rotation which gave three X-flares, including X6.3 the largest of the solar cycle so far) and AR3615 in the southeast. AR3614 has a large main spot with a clear delta configuration, whereas AR3615 has a number of smaller spots, but is showing a couple of delta regions. AR3616 in the west showed signs of decay. AR3607 has seen some growth of intermediate spots recently. A new spot region, as yet unnumbered, is appearing around the southeastern limb and the analysis will be re-assessed as it becomes more clearly visible. The remaining regions currently appear stable or showing slight decay.

Moderate activity is considered likely with a slight chance of becoming High from any isolated X-flares, mostly due to AR3614 and AR3615, but other regions in the west are worth watching too.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: X-ray flux at GOES16 and 18, showing the M7.4 flare earlier today.



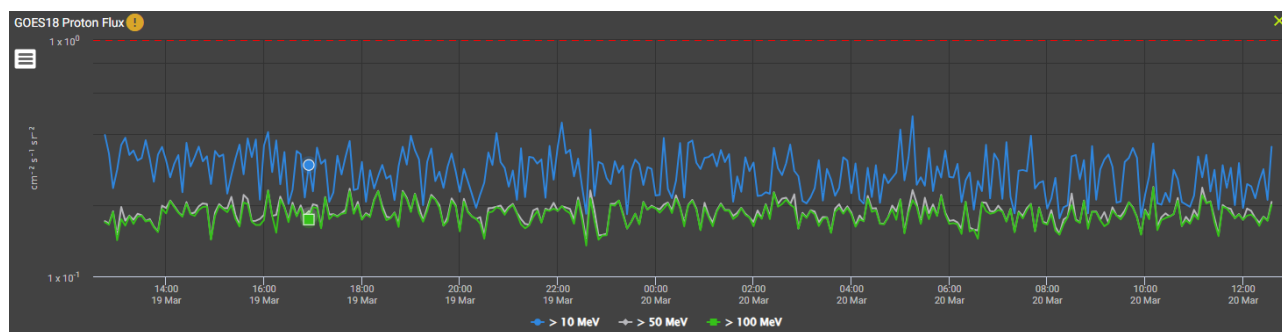
Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is currently just above background levels after falling since the S1 event on 15-16 Mar. Flux is expected to remain at or close to background at first, with further enhancements unlikely. As AR3614 and AR3615 rotate towards centre disc through the period, they move into a slightly better location for proton events to reach Earth and the probability of reaching S1 rises a little.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: Proton flux at GOES18, showing 10MeV protons near to background levels once again.



High Energy Electrons Event ($\geq 2\text{MeV}$):

GOES-16 electron flux is expected to remain at mostly background levels, with no significant sources of enhancement expected. A CME arrival is probable late on Day 1 (20 Mar) with effects into Day 2 (21 Mar), however this isn't expected to have a large impact at Earth. After the CME influence eases off a rise in electron flux is possible as the van Allen belts expand back out again, but unlikely to be significant.

As a result, the associated 24 fluence is expected to remain below the Active threshold, albeit with a very slight rise in probability later in the period.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	5	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM showing a below Active trend through the next three days, which is considered good guidance.

